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II. Solution by **P. H. PHILBRICK**, M.S., C.E., Chief Engineer for Kansas City, Watkins & Gulf Railway Co., Lake Charles, La.

First. To find the time of filling the lower 10 inches of the tank. The head is $h=13.5+6-\frac{5}{8}=18\frac{2}{3}$ feet. Let v=velocity at the outlet, and s=the area of the cross-section of the pipe$=(\frac{1}{4}\pi)(\frac{1}{4})^2=.0491$.

Then $h=v^2/2g+m(v^2/2g)$, or $v=[2gh/(1+m)]^{\frac{1}{2}}$ ......(1), in which m is the sum of the resistances to the entrance and movement of water in the pipe.

The diameter of the tank 10 inches from the bottom is 19.5 feet. Hence the volume of the lower 10 inches of the tank$=(\frac{1}{12}\pi)[(19.67)^2+(19.5)^2+19.67\times19.5]=V$......(2).

Then from (1) and (2), $t=V/vs$..... (3).

According to *Bowser*, Articles 110 and 112, m may be taken$=.03\times1972\div\frac{1}{4}+1.5+.98=238.48$.

Second. To find the time of filling the remainder of the tank. Let x be the height in feet of the top of the reservoir above the surface of the water at the time t. The diameter of the tank at the surface of the water is $17+(\frac{16}{81})(x-6)=15.815+.1975x$. Hence the area is $A=(\frac{1}{4}\pi)(15.815+.1975x)^2=196.4+4.906x+.0306x^2$. Let dx be the rise in the water in the time dt. Then Adx is volume of water admited in time dt ....(4).

We also have, as shown above, $v=[2gx/(1+m)]^{\frac{1}{2}}$, and, therefore, the volume of water admitted in time dt is equal to $[2gh/(1+m)]^{\frac{1}{2}}\times sdt$......(5).

From (4) and (5) we have, $dt=[(1+m)/2g]^{\frac{1}{2}}\times1/s=[(196.4+4.906x+.0306x^2)dx]/x^{\frac{1}{2}}$ .....(6).

Integrating between $x=4=18\frac{2}{3}$ and $x=h=6$, we have $t'=[(1+m)/2g]^{\frac{1}{2}}\times.0491[392.8(H^{\frac{1}{2}}-h^{\frac{1}{2}})+3.271(H^{\frac{3}{2}}-h^{\frac{3}{2}})+0122(H^{\frac{5}{2}}-h^{\frac{5}{2}})$......(7).

$t+t'$=the total time required to fill the tank.

Third. If the inlet pipe projected over the top of the tank, we would have as in equation (1), $v_1=[2gh_1/(1+m)]^{\frac{1}{2}}$......(8), in which $h_1=6$ feet.

Also volume of tank is $V=(\frac{1}{4}\pi)[(19.67)^2+17^2+17\times19.67]$......(9).

Then $T=V/v_1s$......(10).

76. Proposed by **WILLIAM HOOVER**, A. M., Ph. D., Professor of Mathematics and Astronomy, Ohio University, Athens, Ohio.

Show that

$$\log[x-a-b\sqrt{(-1)}]=\tfrac{1}{2}\log[(x-a)^2+b^2]-\sqrt{(-1)}\tan^{-1}\frac{b}{x-a},$$

Naperian logarithms being used.

I. Solution by J. O. **MAHONEY**. B. E., M. Sc., Central High School, Dallas. Tex.; **F. ANDEREGG**, A. M., Oberlin College, Oberlin, O.; **ARTHUR C. LUNN**, University of Chicago, Chicago, Ill.; **COOPER D. SCHMITT**, A.M., University of Tennessee, Knoxville, Tenn.; **BURKE SMITH**. University of Washington, Seattle, Wash.; **H. C. WHITAKER**, A. M., Ph. D., Manual Training School, Philadelphia, Pa.

Let $(x-a)-ib=r(\cos\phi-i\sin\phi)$.

Then $r^2=(x-a)^2+b^2$, $\tan\phi=b/(x-a)$.

Thus $\log[x-a-ib]=\log[r(\cos\phi-i\sin\phi)=\log r+\log e^{-i\phi}=\log r-i\phi$

$$=\tfrac{1}{2}\log[(x-a)^2+b^2-i\tan^{-1}[b/(x-a)].$$

II. **Solution by HENRY HEATON, M. Sc., Atlantic, Ia.; WALTER H. DRANE, Harvard University, Cambridge, Mass.; and G. B. M. ZERR. A. M., Ph. D., Chester High School, Chester, Pa.**

$$\int\frac{\sqrt{(-1)}bdx}{(x-a)^2+b^2}=-\sqrt{(-1)}\tan^{-1}\frac{b}{x-a}=\tfrac{1}{2}\log\left(\frac{x-a-b\sqrt{(-1)}}{x-a+b\sqrt{(-1)}}\right).$$

$$\therefore\ \tfrac{1}{2}\log\left(\frac{x-a-b\sqrt{(-1)}}{x-a+b\sqrt{(-1)}}\right)=-\sqrt{(-1)}\tan^{-1}\frac{b}{x-a}.$$

$$\therefore\ \log[x-a-b\sqrt{(-1)}]-\tfrac{1}{2}\log[(x-a^2)+b^2]=-\sqrt{(-1)}\tan^{-1}[b/(x-a)].$$

$$\therefore\ \log[x-a-b\sqrt{(-1)}]=\tfrac{1}{2}\log[(x-a)^2+b^2]-\sqrt{(-1)}\tan^{-1}[b/(x-a)].$$

PROBLEMS FOR SOLUTION.

ARITHMETIC.

130. **Proposed by H. C. WHITAKER. M.E., Ph.D., Professor of Mathematics, Manual Training School, Philadelphia, Pa.**

How many balls 1 inch in diameter can be put in a cubical box 2 feet in the clear each way, putting in the maximum number?

131. **Proposed by M. A. GRUBER, A. M., War Department, Washington, D. C.**

A right frustum of a cone whose radii of the bases are r and s, $r>s$, is to be divided into n parts of equal volume by sections parallel to the bases. What are the altitudes of the respective parts?

⁂ Solutions of these problems should be sent to B. F. Finkel not later than June 10.

GEOMETRY.

144. **Proposed by L. C. WALKER, Assistant in Mathematics in Leland Stanford, Jr., University. Palo Alto, Cal.**

Find the equations of four cones that pass through three given straight lines intersecting in the same point.

145. **Proposed by FRANK GRIFFIN. Graduate Student, State University, Boulder, Colo.**

If A and B be the points of contact, upon two circles X and Y, of tangents drawn from any point of their circle of similitude, then the tangent from A to Y is equal to the tangent from B to X. [From *Casey's Sequel to Euclid*, Part I., page 114.]

⁂ Solutions of these problems should be sent to B. F. Finkel not later than June 10.

AVERAGE AND PROBABILITY.

95. **Proposed by G. B. M. ZERR, A. M., Ph. D., Professor of Mathematics and Science, Chester High School, Chester, Pa.**

Three random points are taken in an ellipse, one on each side of the major axis and the third anywhere in the ellipse. Find the average area of the triangle formed by joining the three points.